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D'Annone's Meteorological Series from Basel, 1755-1804

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Abstract

The meteorological series from Basel is one of the two currently existing long Swiss series and reaches back to 1755. It has been re-evaluated by Bider et al. (1958) and Bider and Schuepp (1961) based on daily values. In the context of the DigiHom project, we have digitised the original subdaily data. In this short paper we describe the series by D'Annone, covering 1755-1804. We provide information on the observer, location, and instruments and describe the quality control procedures. The data from D'Annone are available from MeteoSwiss and will be merged with other segments of the long Basel series.

1. Introduction

Basel is one of the two very long Swiss meteorological series available until now (the second is Geneva; both reach back to 1755). It is widely used in science and in public communication to demonstrate long-term climate change in Switzerland (CH2018, 2018). As is the case with almost all long series, it is composed of segments of very different length. Most of these segments have been analysed in detail by Riggenbach (1892) and carefully concatenated by Bider et al. (1958) for temperature and Bider and Schüepp (1961) for pressure. In this form the series has found its way into the global data bases (*e.g.,* Menne et al., 2018).

The data 1755 to 1804 in this concatenated series are from one observer: Johann Jakob D'Annone. In the 2000s, the original data have been digitized in the framework of the project DigiHom (Füllemann et al., 2011) and more recently the GCOS Switzerland project "Long Meteorological Series". In this paper we briefly describe this longest segment of the Basel series, which forms the basis of the long series. This paper will be complemented by further

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papers describing other segments of the Basel series, some of which might not have been available to Bider et al. (1958), eventually leading to a new, long Basel series.

The paper is organised as follows. Section 2 describes observer, location, as well as instruments and their errors and assessments by previous authors. Section 3 describes the processing, quality control and analyses of the data. Conclusions are drawn in Section 4. All metadata on the stations are incorporated in the inventory of Pfister et al. (2019); the data can be obtained from the MeteoSwiss website.

2. Observer, location, instruments, and source

Johann Jakob D'Annone (1728-1804) was a scientist from Basel. He studied philosophy and law at the University of Basel. In 1759 he became lecturer for natural history, 1766 professor for eloquence (arts and humanities), later also for jurisprudence at the Basel University (Bühler, 2001). He served the university as dean and rector and left behind rich collections. He was married with Anna Margaretha Burckhardt.

D'Annone performed the meteorological measurements at his house at Heuberg 16 (Fig. 1, 280 m asl). Measurements were performed three times per day. The observation times are indicated only until 1758 (7 am, 2 pm, 8 pm, note that observation times were given in Basel hours, which deviates by one hour from local solar time). Riggenbach (1892) mentions that observations times at the end of the record were 7 am, 3 pm, 7 pm (according to a servant)

Figure 1. Map of Basel from Matthäus Merian the older, ca. 1620, 32.5 x 39.5 cm (copyright: Kunstmuseum Basel). The red dot indicates D'Annone's house, where he performed the measurements.

and assumes without further evidence that the change in observation times took place on 26 February 1780. Bider et al. (1958), though referring to Riggenbach, assume 24 February 1779 as the date of change. We follow this latter date, noting that there is no more precise information.

During three summers, measurements were not taken in Basel, but in other locations, namely Muttenz (20 July to 14 September 1761 and 17 July to 28 August 1784) and Pratteln (18 August to 3 September 1765). D’Annone started his own measurements on 5 June 1755. He complemented the series backward to 1 January by copying the measurements from Friedrich Zwinger (1707–1776), doctor and professor at the university, serving also as dean and later rector.

Temperature measurements were performed with a Micheli Du Crest thermometer filled with spirit of wine, with a bulb diameter of 11 Parisian lines. Temperature is indicated in degrees Micheli Du Crest. Pressure was measured with a “good barometer” (Riggenbach, 1892) with an inner diameter of 1.75 Parisian lines, with a scale in Parisian inches and lines.

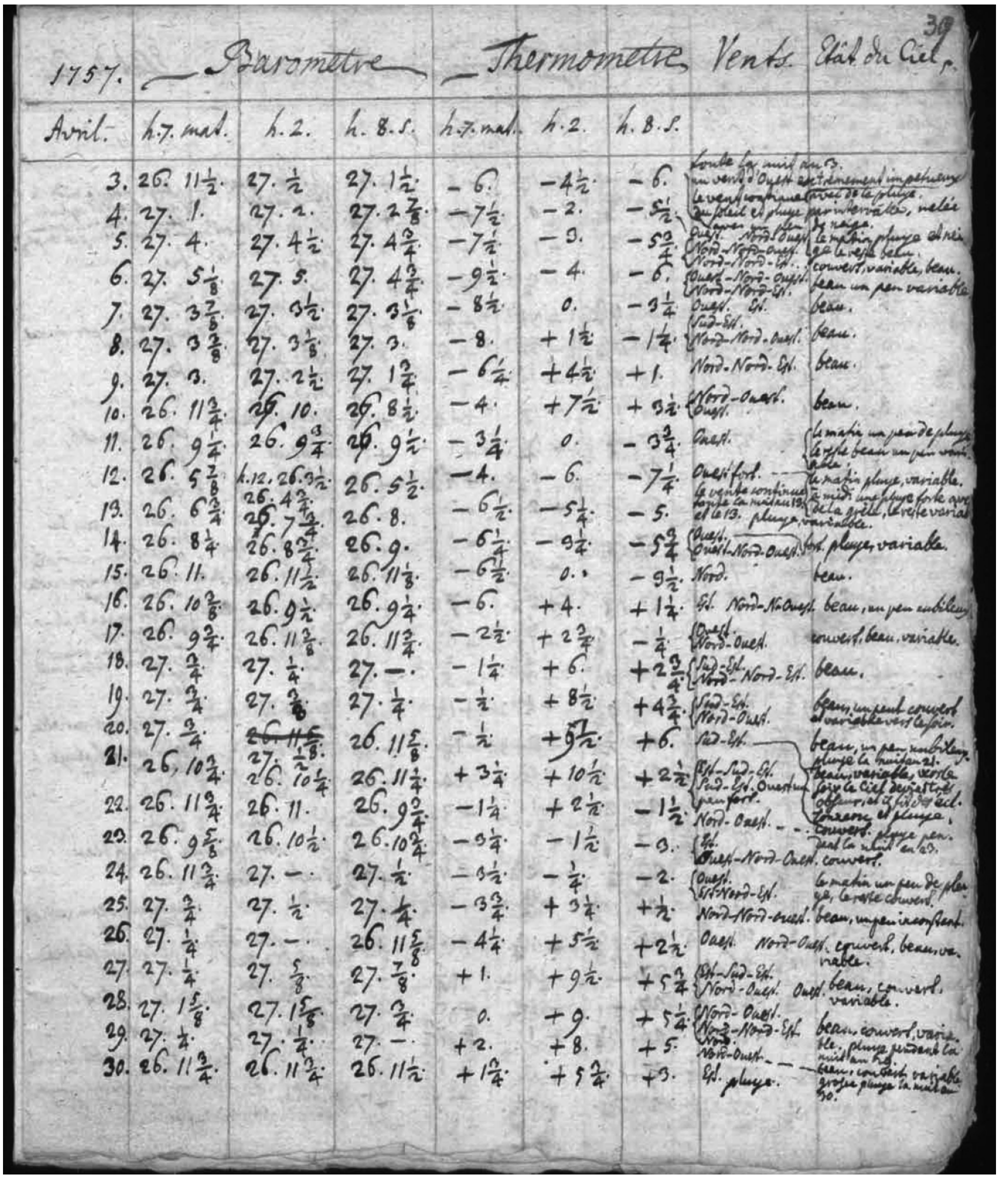

Figure 2. Excerpt of the data sheet for April 1757 (University library Basel).

Bider et al. (1958) note the hesitation of Riggenbach (1892), who analysed the different segments of the Basel series very carefully and also compared the D'Annone series with further series from Basel and vicinity, at times finding large differences (some of them could be instances in which D'Annone did not perform the measurements himself, but a servant who then reported the measurement to him upon return). Furthermore, Riggenbach (1892) found a change in mean temperature around 1772 and assumed a change in the zero point of the thermometer. Bider et al. (1958) analysed morning, noon, and evening series separately and concluded that D'Annone possibly started to change observation hours already in the early 1770s and that a change in the thermometer affected measurements after 1790. They corroborated this by comparing the D'Annone series with series from Neuchâtel (for the 1770s change) and Sulz (for the change after 1790).

Bider et al. (1958) use the D'Annone data based on the data published in the "Annalen der Meteorologischen Zentralanstalt", which they compared with the original manuscripts. They found a change in temperature between 1771 and 1778, *i.e.,* a decrease in the morning reading and an increase in the noon and evening readings, which they attribute to changed observation times. A more gradual increase after 1790 was attributed to a change in the themometer scale and was assumed to grow from 0°C to 0.6 °C based on comparisons with a station in Sulz. For further re-evaluation work, Bider et al. (1958) compared the D'Annone series with series from Stuttgart, Karlsruhe, Strassbourg, Mulhouse, Delémont, Bern and Geneva and estimated a radiation error of 0–2 °C depending on the season. In their final, reduced version, Bider et al (1958) corrected the D'Annone data for radiation error, temperature drift, urban effect, and changes in the time of day of measurements.

Pressure data were not reduced by D'Annone. Bider and Schuepp (1961), using again data from a nearby station, found that the dependence of the pressure difference on temperature levels out at low temperatures and therefore assumed that the room was slightly heated during winter. They found that pressure is generally too low for unknown reasons, but concluded that measurements were taken carefully.

For our work we went back to the original data sheets, which were photographed from the University Library of Basel. An example sheet is shown in Figure 2. The data were transcribed by students in the DigiHom project and in the GCOS project. The handwriting is legible and posed no problems. Concerning the observation times, we followed the assumption of Riggenbach (1892) that a change took place on 24 February 1779.

While the homogenisation of temperature by Bider et al. (1958) was done very carefully and is essential to obtain a series that is as homogeneous as possible, correcting for all possible effects, the current view on correction is different. It is today considered essential to always have the original values at hand in order to be able to reassess any corrections. Urban effects do not need to be corrected for all applications of the data, and having a complete and very long record is perhaps less in the foreground than it was in the 1950s and 1960s. The focus of science has shifted away from mean climate towards extremes and towards analyses of atmospheric processes, which require sub-daily values. For this reason, it may be necessary to un-merge or un-correct some of the series that served science well for many decades. Therefore, this paper focuses on the original data. A construction of a new, homogenised combined series (for those applications that require long time series at monthly scale) will follow later using new segments from other series that were unknown to Bider et al. (1958).

3. Processing and quality control

The data from D'Annone were quality controlled (QC'ed) and processed as described in Brugnara et al. (2020a). For temperature the QC procedure flagged 169 values (out of 54498), for pressure, 580 values were flagged (again out of 54498).

Scatter plots comparing observations of temperature and pressure for different times of the day are shown in Figure 3. Pressure shows high correlations, *i.e.,* 0.97 for morning versus noon and noon versus evening measurements. The fact that morning and evening are correlated worse is entirely explainable by the changing weather. For temperature, the corresponding plots again show high correlations, in particular between afternoon and evening. These plots therefore show that the precision of the data, both pressure and temperature, is very high.

Box-plots of temperature and pressure by calendar month (Fig. 4) show the expected distributions and seasonal patterns. Temperature shows a skewed distribution during the winter months, particularly for the morning measurement, while the distributions during summer and at noon are more symmetric. Pressure shows the expected minimum in April and again an asymmetric distribution. However, as already mentioned, the barometer readings were not reduced to a constant temperature.

The temperature measurements follow a realistic diurnal cycle in summer, close to that measured at the modern station of Basel/Binningen although with a hint of slight radiative bias in the afternoon hours (Fig. 5). The winter data show larger deviations. While the local climate of Basel/Binningen and the city might differ, the deviations still require further attention.

Finally, we also analysed the long time series of the D'Annone data. Figure 6 shows annual and seasonal mean temperature as well as monthly pressure data. The temperature

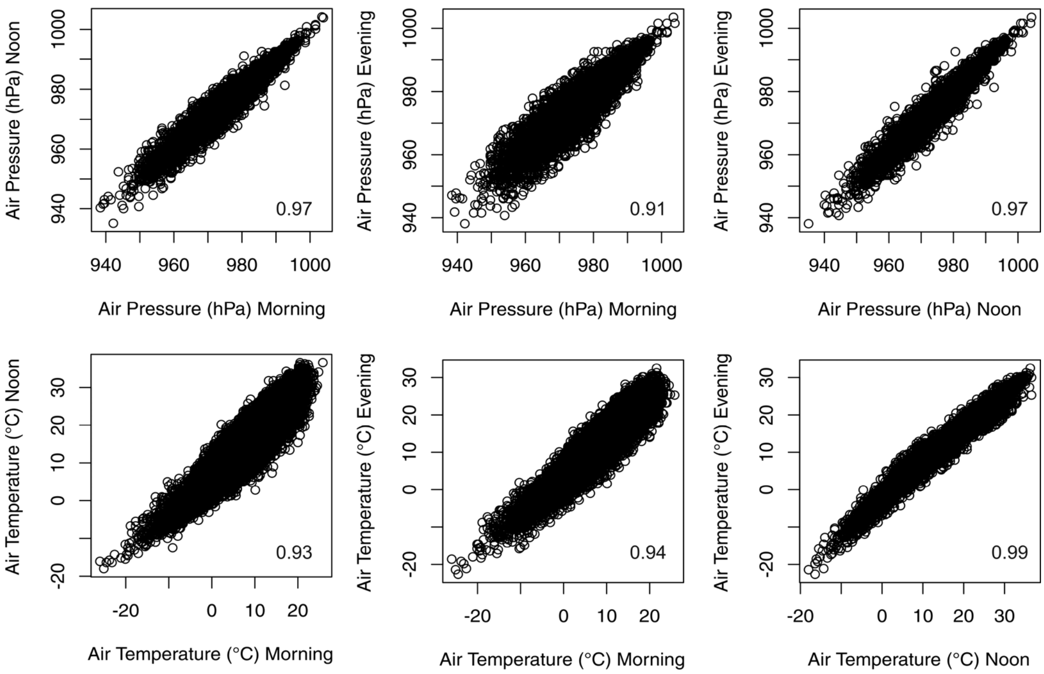

Figure 3. Mutual comparisons of morning, noon, and evening series (the number indicates the Pearson correlation coefficient) of pressure (top) and temperature (bottom) in Basel in the series from D'Annone, 1755-1804.

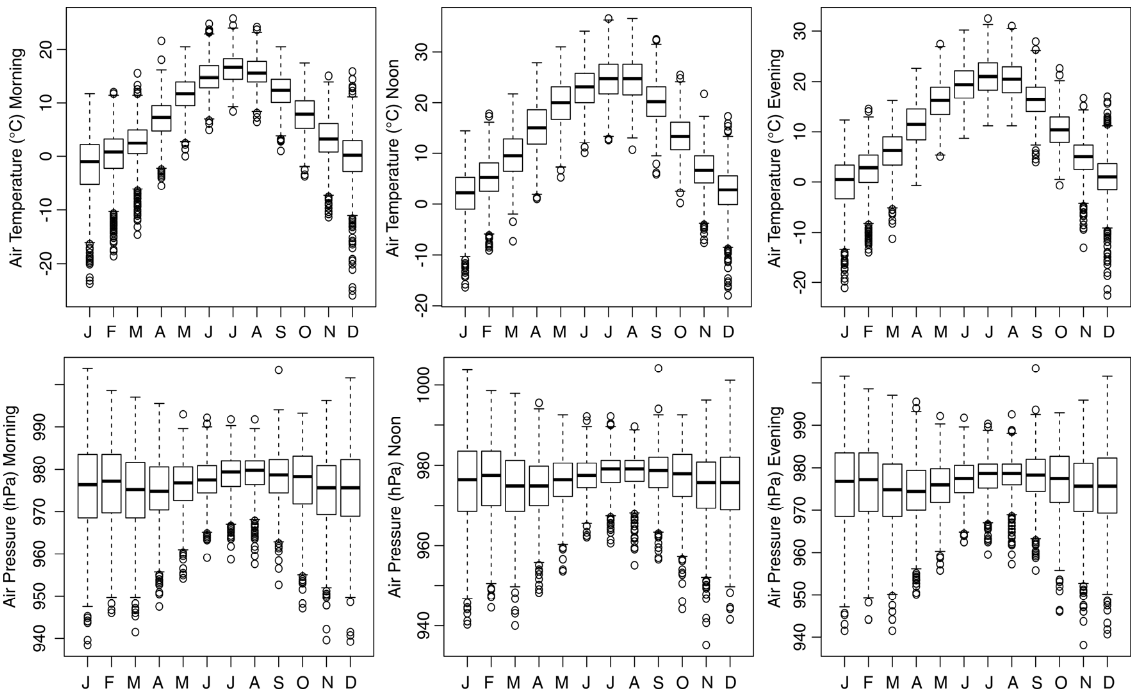

Figure 4. Boxplots for (top) temperature and (bottom) pressure for morning, noon, and evening series as a function of calendar month (box indicates quartiles and median, whiskers extend to at most 1.5x the interquartile range from the box).

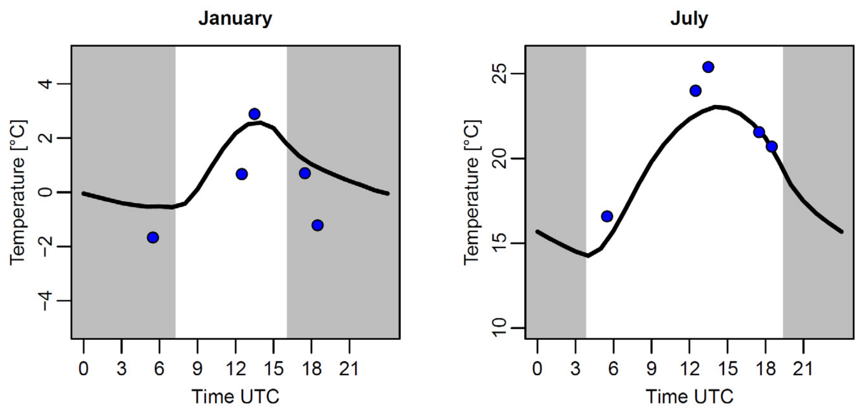

Figure 5. Average temperature values for the 3 observation times in January and July (dots) compared with the mean diurnal cycle at Basel/Binningen during 1981-2010 (1°C has been subtracted). Gray areas indicate nighttime.

series confirm some known features of the temperature evolution, such as the high temperatures around 1800 (Böhm et al., 2010; Brönnimann, 2015). The coldest year (annual mean temperature) was 1758, the warmest years was 1801. Bider et al. (1958) attribute this warming around 1801 to errors in the thermometer. However, we know today that temperatures were higher in these years and weather type statistics indicate a higher fraction of high-pressure types from spring to fall during these years (Auchmann et al., 2012; Schwander et al., 2017). Without further evidence – statistical or metadata – a correction cannot be sustained.

The well-known cold winter of 1788/89 (Neumann and Detwiller, 1990) is also noteworthy, although 1765/66 was even colder. Another cold winter was 1783/84, which coincided with the Laki eruption. The cold spring 1785, one year after the end of the eruption, however, must be attributed to other causes. Among the coldest summers are those of 1769 and 1770, coinciding with the start of a food crisis (Pfister and Brazdil, 2006).

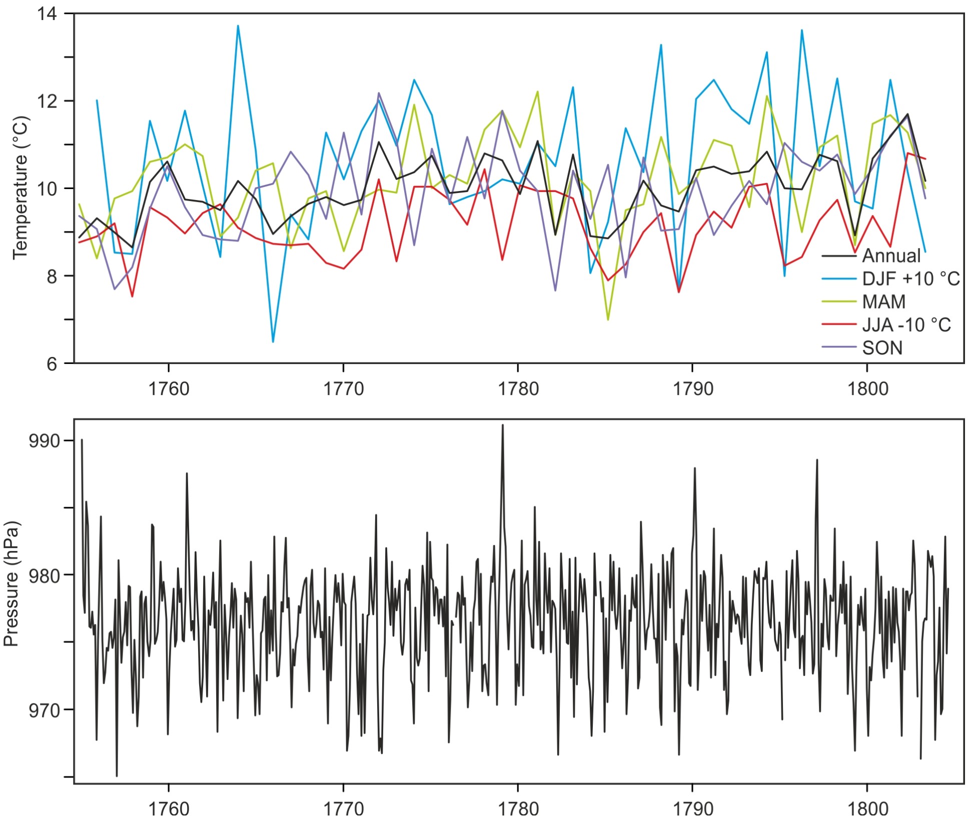

Figure 6. Time series of annual and seasonal mean temperatures (top) as well as monthly mean pressure (bottom) in the D'Annone data from 1755 to 1804.

The pressure series (Fig. 6, bottom) shows rather random variations. A visual inspection does not reveal any obviously inhomogeneous period or erroneous value except perhaps the first monthly value of the series which incidentally is the second highest of the series. Overall there is no reason from these preliminary plots to assume that the data could have problems.

Bider et al. (1958) mention several corrections that need to be undertaken to generate a long, homogeneous Basel temperature series: a) radiation error, b) correct to daily mean c) correct for urban effect in the D'Annone series as compared with the more rural or suburban location of Basel-Binningen. d) Zero-point correction of the temperature scale of the thermometer, e) calibration correction of the thermometer. They tried to the best of our knowledge, by comparison with other series, with cloud cover. This information will prove useful in a reassessment of the Basel series. However, the original value must be preserved, and depending on the application, not all corrections are necessary.

5. Conclusions

The meteorological series from Basel, together with that from Geneva, is the longest currently known from Switzerland. Here we analyse a segment covering the first 50 years, from 1755 to 1804. The data were measured by Johann Jakob D'Annone, scientist and university professor. Quality control and analyses find the data to be of good quality. The data have been re-evaluated carefully in the 1950s; they have now been re-digitised based on the original subdaily data and will be complemented and compared with further records from Basel that have only come to light recently (Pfister et al., 2019).

The data are made publicly available by MeteoSwiss. They will also be available from the C3S data Global Land and Marine Observations Database (Thorne et al., 2017).

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